**Iron Isotopes in Utah Hematite Concretions: A Terrestrial Analogue for Martian Blueberries**

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**Introduction:** Hematite concretions ($\text{Fe}_2\text{O}_3$) are usually precipitated from aqueous fluids. The discovery of such concretions by the Mars Exploration Rover mission revived the idea that liquid water was present on Mars at some stage in its history. Recent studies characterized spherical hematite concretions in the Jurassic Navajo Sandstone (southeastern Utah) and showed that they may represent the best terrestrial analogues for Martian “blueberries” [1]. In order to better constrain the conditions that governed the formation of Utah hematite concretions, we analyzed their iron contents and isotopic compositions. Measurements were performed by MC-ICPMS (Isoprobe) at the Isotope Geochemistry Laboratory of the Field Museum. Iron isotopic composition ($F_{\text{Fe}}$) is expressed as per mil per atomic mass unit (‰/amu) deviation relative to the IRMM-014 standard.

**Results and Discussion:** Bulk rock Fe contents range from 8.5 to 15.5 wt%. The Fe isotopic composition shows a large range of variation, from $-0.319\pm0.053$ to $-0.705\pm0.045$ ‰/amu. These variations may arise from changes in the composition of the fluid source or the conditions of precipitation. In natural environments, iron is known to be mobile in fluids as ferrous iron ($\text{Fe}^{2+}$), while ferric iron ($\text{Fe}^{3+}$) is generally immobilized by precipitation of iron oxides or hydroxides. The oxidation of aqueous $\text{Fe}^{2+}$ into $\text{Fe}^{3+}$ enriches the product in heavy Fe isotopes (up to $+1.4$ ‰/amu at 25°C) [2]. In contrast, hematite precipitation from aqueous $\text{Fe}^{3+}$ is associated with kinetic isotope fractionation, which enriches the precipitate in the light Fe isotopes [3]. This kinetic fractionation is proportional to the rate of hematite precipitation and close to 0 ‰ when the reaction is slow. Assuming that $F_{\text{Fe}}$ of initial aqueous iron was around 0 ‰, like most detrital iron-bearing sediments [4], one would expect $F_{\text{Fe}}$ values of Utah hematite concretions to be positive (slow precipitation) or close to 0 ‰ (rapid precipitation). Various processes related to mobilization, transport and precipitation [4, 5] can be advocated to explain the very negative $F_{\text{Fe}}$ values presented herein. The primary source of iron could have had negative $F_{\text{Fe}}$ values and only limited isotopic fractionation would have been produced by Fe mobilization and subsequent precipitation. In contrast, if the source of iron had $F_{\text{Fe}}$ values close to 0 ‰, Fe mobilization and/or precipitation may have been associated with kinetic isotopes fractionation favoring the light isotopes. An alternative explanation would be that successive precipitation of iron oxides, enriched in heavy isotopes, induced a decrease of the $F_{\text{Fe}}$ value in the remaining fluid. Subsequent hematite precipitation from this evolved fluid would have been characterized by negative $F_{\text{Fe}}$ values.

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